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ABSTRACT

A study of vowel substitution in Finnish learners of English as a second language looked at the quantitative characteristics of qualitatively similar vowels under different tempo conditions. Specifically, it compared the effects of rate of speech and vowel duration on the eleven stressed monophthongal English vowels and their Finnish counterparts. Tape recordings of instances of the vowels were translated onto an oscillograph, and trace intervals representing the object vowels were segmented, measured, and statistically analyzed. Marked interlingual differences were found, with English relying more on qualitative vowel features and Finnish relying more on quantitative features for distinguishing between phonemes. In Finnish there appears to be systematic pressure for homogeneity within phonemic length categories that is strong enough to level out inherent durational differences between qualitatively different vowels. The duration of English vowels appears to be less affected by changes in speech rate. The report stresses that the results are statistical and not linguistically-based, and that further linguistic and perception testing is necessary to assess the linguistic significance of the findings. (MSE)

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SPEECH RATE AND QUANTITY OF VOWELS IN ENGLISH AND FINNISH

1. In a typical L1/L2 communicative situation, the only practically possible aspect that you can try to influence -- apart from asking for repetitions -- in the speech of your interlocutor is his or her rate of delivery. It is therefore surprising how little is really known about the effects, phonetic or otherwise, of tempo changes on the linguistic signal, relevant as they must be for communication, particularly between native and non-native speakers of a language.

In the instrumental study of spoken English there has been a marked shift since the pioneering days of E.A. Meyer (1903) towards a well-nigh exclusive interest in the qualitative aspects of the sounds. And where quantitative research has been conducted, the following statement of another classic, B. Malmberg (1944:6), seems to have been denied its crucial importance: "erstens beruht die Quantität jedes einzelnen Sprachlautes auf dem allgemeinen Tempo der Rede." In the field of English speech studies this appears understandable -- even if not excusable -- for three interlinked reasons.

The phonological system of English does not utilize sound length as an independent phonemic feature; consequently, autonomous descriptions of English naturally tend to overlook quantitative matters. The focus of interest then guides the construction of new instruments, which become less suitable for investigating less popular parameters of the speech signal. And finally, wherever quantitative phenomena do come to be looked at, they are viewed in a fashion similar to the mode of approaching qualitative (spectral) characteristics: without feeling a necessity to account for the rate of speech prevailing in the production of the utterances constituting the research material. If we accept the broad generalizations made above as valid at least to some degree, it is easy to appreciate one reason why the mainstream thinking in the field of instrumental speech analysis has not been particularly congenial to an adequate study of genuine, spontaneous spoken discourse. It is only

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fairly recently that there has been a wider rekindling of interest in the prosodic or suprasegmental aspects of speech in the English-speaking world.[1] A considerable impetus for this has come from the field of applications: as work on various forms of automatic speech recognition apparatus proceeded, it soon became obvious that more detailed information about the temporal aspects of English, among them subphonemic segmental duration and its parameters, was vital for the construction of devices capable of successfully receiving and processing real human speech in at least some of its variety.

Some of the quantitative characteristics of English sounds -- now seen as necessary to be specified for machines -- have traditionally been regarded as central features to be accounted for, in some form or another, by teachers of English as a foreign language, especially by those working with learners whose L1 exploits quantity in a clearly linguistic function, as is the case in Finnish.[2] The following is a brief report on some aspects of an experimental acoustic investigation into the quantitative characteristics of qualitatively similar English and Finnish vowels under different tempo conditions. Although the research rationale was the one broadly hinted at above, the present writer wishes fully to recognize the danger articulated by K. Suomi (1980:16) of "useless pseudo-applications (of which there is no particular shortage in the gallery of contrastive analysis)."

2. The study was focussed on the eleven English stressed monophthongal vowels and their Finnish counterparts, which can be claimed to reflect the tendencies of substitution commonly exhibited by Finnish learners of English (e.g. Wiik 1965).

English	Finnish
ɪ iː	i ii
ʊ uː	u uu
ɔ oː	o oo
ʌ ɑː	a aa
e	e
ɜː	ö öö
æ	ä ää

The sounds were embedded as the first, stressed vowels in words of the structure type $C_1V_1[C_2(V_2)]$, allowing only those sound combinations

which are phonotactically possible both in English and Finnish; in other words, they constituted "cross-linguistic homophones." Each informant read his or her material (the test words of his or her L1 in a sentence frame) three times over, first at a normal tempo, then at a fast, and finally at a slow rate of speech. Consequently, the factors affecting the duration of the object vowel came to be the following.

			e.g.
1.	Language	(1-2)	English
2.	Sex of Speaker	(1-2)	male
3.	Informant	(1-2)	E1
4.	Rate of Speech	(1-3)	normal
5.	Qualitative Category	(1-7)	i-like
6.	Quantitative Category	(1-2)	/short/
7.	Structure of Word Frame	(1-2)	monosyllabic
8.	Class of Following Consonant	(0-4)	$-c_1$
9.	Identity of Following Consonant	(0-8)	-k
10.	Identity of Preceding Consonant	(1-11)	k-
11.	Occurrence of Vowel Segment		V_n

The present discussion will be restricted to some of the effects attributable to factors 1, 4, 5, and 6 only.[3]

The tape recordings were translated into optical form by means of an ink-jet oscillograph, and trace intervals representing the realizations of the object vowels segmented and measured. Ordinary statistical description and analysis of the values was carried out for relevant categories of the material: means and standard deviations computed, t tests and analyses of variance performed, and correlation coefficients and best-fit lines determined.

2.1. Obviously, the physical quantity of both the English and the Finnish vowels under study shortens when the tempo of speech grows faster, and lengthens under the influence of a slower rate of production. However, marked interlingual differences also prevail, as evidenced by figure 1 (next page), which is based on relatively high-level means of observed segment durations. All eleven English qualitatively different vowels also differ from each other quantitatively: the so-called /short/ and /long/ vowels could well be collapsed into a single sequence of individual sounds durationally distinct from the others, with /æ/ acting as a link between the five vowels towards the shorter and the five vowels

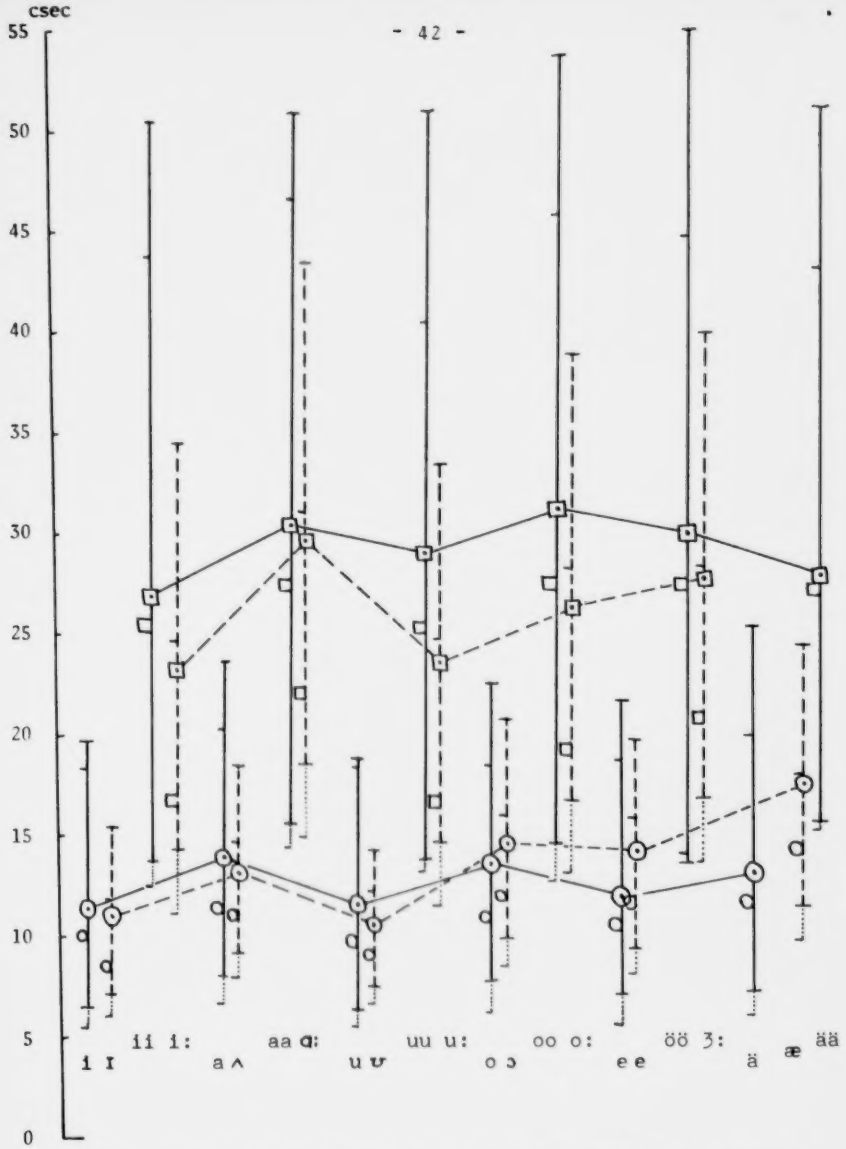

Figure 1. Absolute vowel duration data for English and Finnish arranged to demonstrate effects of changes in the rate of speech. Solid line stands for Finnish, dashed line for English. Dotted circles represent durational means of single/short vowels in monosyllabic words produced at normal tempo, dotted squares denote those of double/long vowels. The upper and lower termini of each vertical bar show the average vowel duration in slow and fast speech, respectively. Circles, squares and dashes to the left of the bars indicate the corresponding values for disyllabic words.

towards the longer end of the scale. The Finnish pattern is essentially different; the /single/ and the /double/ vowels constitute two conspicuously separate quantitative categories, whose members are extremely uniform in physical quantity within their category. These patterns are, of course, due to a systemic difference between the languages; in English, the qualitative features have the primary function of distinguishing between the vowel phonemes, whereas Finnish has to operate with quantitative cues alone. The systemic pressure for homogeneity within the phonemic length categories of Finnish seems to be so strong as to level out the inherent -- and at least to some extent universal -- durational differences between qualitatively different vowels. This is particularly apparent, irrespective of tempo, in the /double/ category, where one would naturally expect greater quantitative variation than in the /single/ class, in the fashion observable within the corresponding English sounds.

The durational means of the English vowels appear to be less affected by changes in speech rate than their Finnish counterparts; the portions of the lines extending upwards and downwards from the circles and squares are shorter for English than the corresponding lines representing the relations in Finnish. No doubt this observation concerning the stressed vowels can be related to interlinguistic timing differences above the segmental level.

2.2. Concretizing into an optical form the distributions of the original, individual segment duration measurements beyond the means, but pooling the different vowel qualities, we get figure 2 (next page). Again, tempo changes move the distribution of the Finnish vowels drastically along the durational scale, the situation of the English values remaining more stable. The paramount overall disparity is that the realizations of the eleven English vowels fill out a single bell-shaped distribution area, while the Finnish graph is clearly bipartite, reflecting the essential distinction, under all tempo conditions, between the /single/ and the /double/ quantitative categories.

2.3. From a Finnish viewpoint at least, it is interesting to establish the durational residue between the /short/ or /single/ and the /long/ or /double/ vowel categories, respectively, both in absolute and relative terms. Under the influence of the Finnish spelling system for one thing (e.g. a:aa for /single/ and /double/ vowel), a Finn has the proclivity to assume that this residue is 50 per cent, and also to transfer this assumption to apply to the sounds of English, too. When

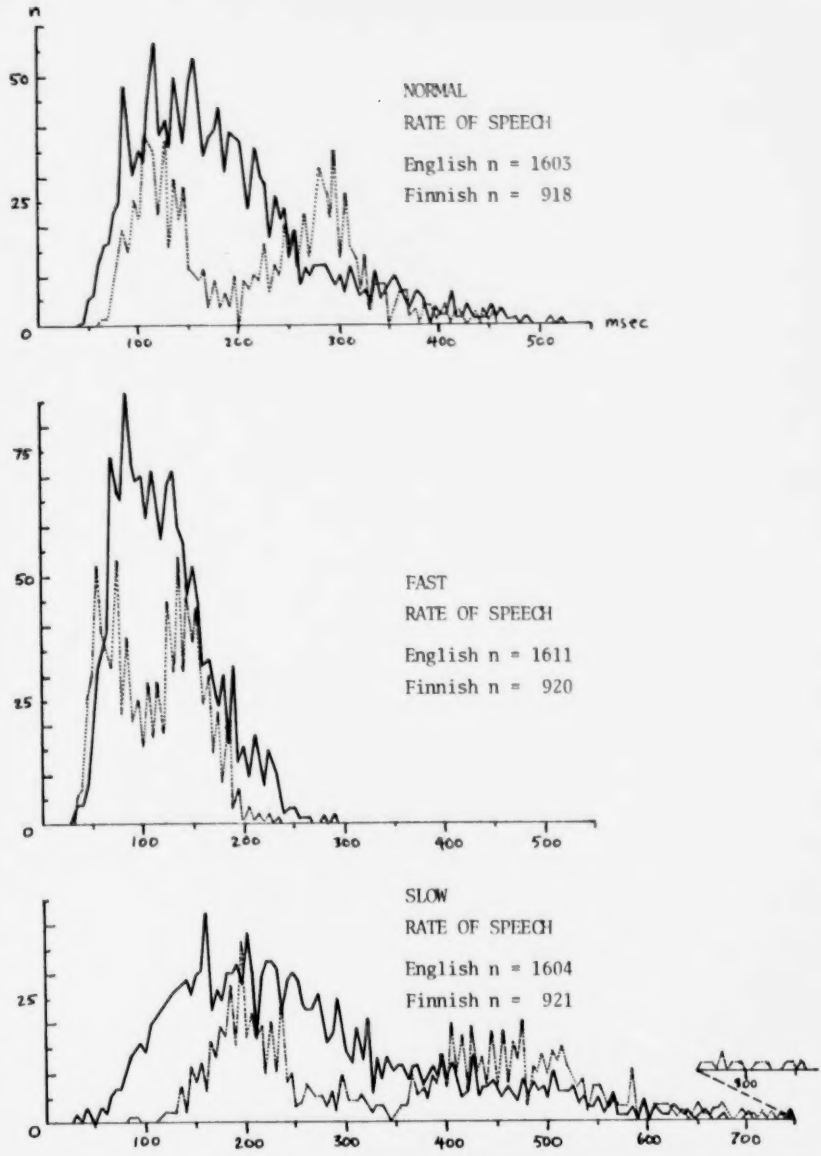

Figure 2. Distribution of vowel durations under different tempo conditions. The graphs are based on the original, individual measurements of phone durations. Duration on x axis, number of occurrences on y axis. Solid line = English vowels, dotted line = Finnish vowels.

the absolute quantitative values observed in the course of the present study are converted into overall ratios by marking the duration of the /short/ and /single/ vowel as 1, we get the following. (Ratios of /short/ vowel to the quantitatively neutral /æ / are given in brackets.)

	normal	fast	slow
English	1:1.9	1:1.8	1:2.0
	(1:1.4)	(1:1.3)	(1:1.3)
Finnish	1:2.4	1:2.1	1:2.3

So it is in fact English that is closer to bearing out the "Finnish hypothesis" of a 1:2 ratio. Whatever the conditions created by speech rate, the absolute measure of distinction between the phonemic length classes in Finnish must be more than 50 per cent; the residue seems to be at its greatest in the normal tempo category. The quantitatively characteristic neutral position of the English /æ / between the so-called /short/ and /long/ vowels might also be worth noting. One of the cross-lingual consequences of the fact that the English ratios are of the order of 1:1.9 is that Finnish listeners are still likely to hear the contrast as identical to /single/:/double/ -- the minimum Finnish ratio between the longest vowel perceived as /single/ and the shortest vowel perceived as /double/ being about 1:1.9 (Lehtonen 1970:89) -- thereby hypostatizing the length of English vowels, very probably at the expense of qualitative differentiation.

2.4. In order to obtain a view of the linguistic quantity distinction in relative terms, statistical significance tests were performed on the residues transmuted into percentages. One intralingual and one inter-lingual test are reported here. The statistical significance of the effects in English and Finnish of changes in the rate of speech on the magnitude of length distinction observed in the normal tempo category (marked as 100 per cent) was determined. The effects were found to be "strongly significant" (risk percent less than 1 in all qualitative categories but one, where it was less than 2 per cent) in both languages. The possible significance of cross-lingual differences in length distinction was established after marking the "ideal" (for a Finn) residues observed in Finnish as 100 per cent and transforming the English values in proportion. Again, the disparities tested were in general strongly

significant in all qualitative vowel categories. As for the influence of tempo, only a fast rate of production seems to confuse the patterns to some degree, possibly a reflection of differences in the effects of stress and/or different basic timing models of the two languages. Statistically speaking, there can be no doubt about the significance of tempo changes on the patterns of physical quantity of vowels in English and Finnish.

3. It is quite obvious that any adequate statement of sound duration patterns must be extended beyond the limits of a segment. As far as speech reception is concerned, the quantity of an acoustic interval is perceived in relation to its environment. Segment durations are processed within a framework of speech rate data obtained by viewing the incoming signal through a window which must be of the order of several syllables. However, while the ultimate aim of the description has to be set at this level, in a cross-linguistic study of this type of phenomena it seems necessary first to delimit the number of factors affecting segment duration, both linguistic and non-linguistic, to a more manageable number, and to confine the investigation to one level of analysis.

The crucial question of statistical vs. linguistic significance in the present area naturally also requires extensive assessment by means of perception tests before any definitive comprehensive statement can be attempted.

In continuation, the scope of the study is being widened to take into specific consideration the effects of the phonetic environment of the interval and also the quantitative interrelations within a word of its constituent sound segments. The validity of the results of the study outlined above will in part be put to test by bringing English and Finnish into contact in interlanguage material -- symmetrical with that of the investigation reported here -- produced by L2 speakers of English and Finnish.

NOTES

1. There have, of course, always been notable exceptions to this apparent lack of interest in things prosodic, both in and outside the English-speaking world, not least in the Nordic countries.

2. Both researchers and pedagogues working in Finland have addressed themselves seriously and successfully to quantitative questions. To name but a few works representing the first category, the contrastive dissertations of K. Wiik (1965), V. Vihanta (1978), and K. Suomi (1980), and the autonomous description of Finnish by J. Lehtonen (1970) might be mentioned, as well as the research of A. Iivonen (e.g. 1978). The most

recent textbooks include K. Sajavaara & J. Lehtonen & A. May (1977) and I. Morris-Wilson (1981).

3. For a fuller scrutiny of the results, with some of the relevant numerical data, see Marjomaa (1983).

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